The Science of Astronomy and the Astrolabe

The ability of Islamic civilization to perfect what it inherited, and to endow what it made with beauty, is nowhere better expressed than in the astrolabe. The technology for making an astrolabe was inherited from the Greeks and its invention is credited to the astronomer Hipparchos of Nicea in the 2nd century BC. The basic scientific principles were described by the Alexandrian astronomer Ptolemy, whose *Planispherium* was translated into Arabic in Baghdad by Hunain ibn Ishaq (809–73), a brilliant linguist, scientist and physician. Using the knowledge of the ancients and their own observation as a basis for experimental research, the Arab astonomers of the 10th century made the most extraordinary scientific advances. These included measuring the circumference of the earth to within 3.6 per cent accuracy, compiling astronomical charts of the motion of planets and determining the shape of their orbits. Their work was not only of importance for the Islamic world, but also for Europe where a Latin translation of Mashallah's text on astrolabes was already available in 1276. Much of this knowledge was made possible by the accuracy and flexibility of the astrolabe, aptly called the 'mathematical jewel'.

The astrolabe is an early form of computer, which simulates the apparent rotation of the stars in the sky about the celestial pole. It may be used to solve many astronomical and astrological problems as well as for navigation and surveying, for telling the exact time of day or night (essential for fixing the times of prayer), and as an accurate calendar for predicting the seasons. On the planispheric astrolabe, the celestial sphere is represented on a flat surface by a mathematical process known as stereographic projection, as a flat map represents the globe. This allows circles to be transferred from a sphere to a flat surface without distortion and retains the true value of an angle between two lines drawn on a sphere. Thus, line horizon, tropics, equator and ecliptic remain circles, or parts of circles.

◄ 64 Planispheric Astrolabe

Made by Hamid bin Mahmud al-Isfahani

Iran, 547 AH/1152–3 AD
Brass
Diameter: 13.15 cm

Signed on the back, this astrolabe is the only published instrument made by Hamid bin Mahmud al-Isfahani. Two of his sons were also metal workers: Muhammad bin Hamid al-Isfahani, the maker of four surviving astrolabes; and Masud bin Hamid bin Mahmud al-Isfahani al-Asturlabi, of whose work there only survives a pen box.

This piece is similar to other 11th and 12th century examples from Iran. It is finely engraved and inscribed in Kufic, and it exhibits the two holes adjoining the suspension ring that are associated with the first Islamic astrolabes. It has a high throne, pierced with a foliated design, and a simple rete with dagger-shaped pointers identifying 27 stars. It has three plates.

Provenance: Negrotto Collection
Samuel Verplanck Hoffman Collection
New York Historical Society
National Museum of American History Smithsonian Institution
Linton Collection

(*continued*)

Published: R. T. Gunter, *The Astrolabes of the World*, Oxford, 1932, no.4.
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E. Combe, J. Sauvaget, G. Wiet, *Répertoire Chronologique d'Epigraphie Arabe*, Cairo, 1937, p.263.
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D. S. Price, S. L. Gibbs, J. A. Henderson, *A Computerised Checklist of Astrolabes*, Yale University, 1973, no.4.
J. D. North, "The Astrolabe," *Scientific American*, Jan. 1974, vol. 230, no.1, p.98.
A. Brieux, F. Maddison, *Répertoire des Facteurs d'Astrolabes et de leurs Oeuvres*, Paris, to be published.

◄ 65 Planispheric Astrolabe
Made by Ahmad bin Husayn bin Baso

Spain, 704 AH/1304–5 AD
Brass
Diameter: 16.5 cm

This astrolabe is solidly made and finely decorated. Inscribed in Maghribi script, it has nine plates, an unusually large number. Two of them are later replacements. The instrument is signed by the craftsman on the back, and three other astrolabes signed by him are also known.

The maker of this astrolabe, Abu Jafar Ahmad bin Husayn bin Baso (d. 1309–10), was a famous astronomer and Muwaqqit of the Grand Mosque of Granada when the kingdom of Granada flourished under the Nasrids. According to the historian, Ibn al-Khatib, he was taught by his father and became unique in his time for the construction of scientific instruments. His work, known for the beauty of its inscriptions, its balanced design and the accuracy of the star positions, surpassed that of the Andalusi makers of earlier eras. People of the period vied with each other to buy Ahmad bin Husayn's instruments.

Provenance: Samuel Verplanck Hoffman Collection
New York Historical Society
National Museum of American History Smithsonian Institution
Linton Collection

Published: R. T. Gunter, *Astrolabes of the World*, Oxford, 1932, vol. 1, p.289, no.144.
H. Michel, *Traité de l'Astrolabe*, Paris, 1947, p.181.
H. M. Holloway, *Check-list of the Samuel Verplanck Hoffman Collection of Astrolabes*, New York, 1946, p.68.
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D. S. Price, S. L. Gibbs, J. A. Henderson, *A Computerized Checklist of Astrolabes*, Yale University, 1973, no.144.
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◀ 66 Planispheric Astrolabe
Made by Muhammad Mahdi bin Muhammad Amin al-Yazdi

Iran, circa 1660
Brass set with turquoise
Diameter: 11.75 cm

This astrolabe, originally set with 24 turquoises of which one is now missing, exhibits extraordinarily fine engraving. Its superior design and detailed notations make it convenient to use and to read. The rete is made for 25 stars with leaf-shaped star-pointers engraved with the names of the stars.

It was made by Muhammad Mahdi ibn Muhammad Amin al-Yazdi, the craftsman responsible for at least twelve other recorded astrolabes. The other examples, ranging in date from 1659 to 1668, provide an approximate date for this one.

Provenance: Linton Collection

Published: R. T. Gunter, *The Astrolabes of the World*, Oxford, 1932, pls. XL–XLI.
D. S. Price, S. L. Gibbs, J. A. Henderson, *A Computerised Checklist of Astrolabes*, Yale University, 1973, p.366–67.

67 Calendar

Turkey, circa 1804
Ink, color and gold on paper; mounted on wood
Height: 44.7 cm
Width: 36.8 cm

This is an elaborate calendar which was painted on paper and then mounted on wood. In the cartouche at the top is a Turkish poem about time, and in each corner is a floral bouquet. The months appear in the disks in the outermost ring of the circular calendrical portion of the piece. The days are noted in the inner ring of smaller disks while the years are indicated on the spokes which radiate from the center. By rotating the inner circle in relation to the outer ring, the calendar could be adjusted for accuracy from 1804 to 1925.

68 Treatise on Astrology

Turkey, 1232 AH/1816–17 AD
Ink and color on paper
Page size: 17 cm × 12 cm

This Turkish manuscript consists of 144 folios on which the text is copied in black ink and important words or phrases are executed in red. It is supplemented with numerous representations of the zodiacal signs and the heavenly spheres, and accompanied by tables and diagrams. The circular format of many of the paintings, and their thinly applied color, give a technical text considerable aesthetic appeal.

◄ 69 Celestial Globe
Made by Muhammad Salih Tatawi

India, 1074 AH/1664 AD
Brass
Diameter: 26 cm

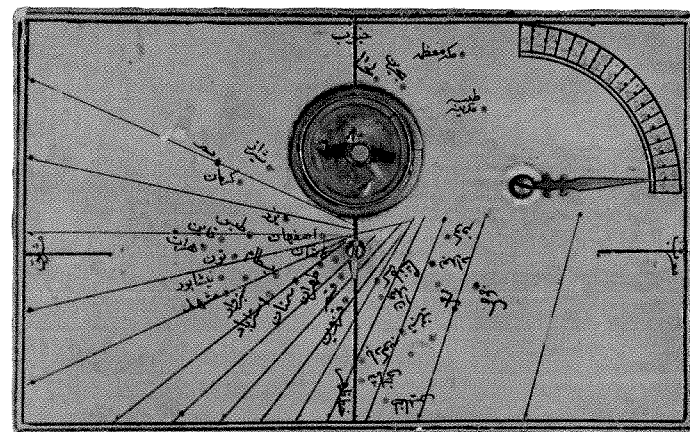
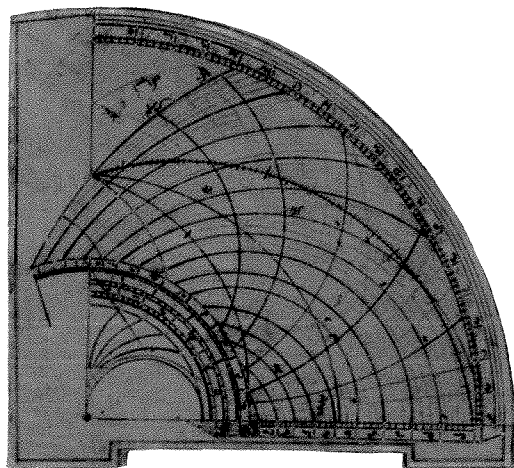
This globe is dated and signed by Muhammad Salih Tatawi, a third generation craftsman from a family of remarkable astrolabists in Lahore. The globe was cast in one piece, while the stand probably dates from the 18th century. An inscription added in Negari script includes a dedication to the shrine at Nathdawara and suggests that it was the gift of the astronomer Prince Jai Singh.

The thousand fixed stars, denoted with silver inlay, are set within finely-engraved pictorial representations of the constellations and the signs of the zodiac. Each of these is inscribed with its name according to the system of Abd al-Rahman al-Sufi (903–86). One of the greatest Muslim astronomers, he wrote a book entitled *The Book of Fixed Stars* in which he gave a complete description of each constellation, drawing on his own insights as well as those of Ptolemy and the Arabs of the desert.

70 Two Astronomical Quadrants

◄ a. Turkey, 19th century
Lacquered wood
Radius: 14.8 cm

b. Morocco, 19th century
Brass
Radius: 15.8 cm

The quadrant, a simplified version of the astrolabe, was developed in the 11th-12th century in Egypt. Generally made of metal, they were occasionally executed in wood like the Turkish example here and, more rarely, carved in ivory. With a quadrant, one could tell time, solve trigonometry problems and undertake basic astronomical calculations for a single location. (a) is set for the latitude of Istanbul while (b) is set for the latitude of Fez.

◄ 71 Qibla Indicator

Turkey, circa 1800
Paper on wood, painted and lacquered
Size: 12.4 cm × 7.8 cm

A compass is set into the upper side, which is designed as a sun-dial with an articulated brass needle, and there is a 90° scale with a brass pointer to the top right. On the reverse is a gazetteer for 96 cities.

Architectural Decoration

◄ 72 Panel with Carved Inscription

Egypt, early 13th century
White marble
Height: 24.2 cm
Length: 57.8 cm

Inscriptions: "There is no God but Allah, and Muhammad is His Prophet"

During the Ayyubid and Mamluk periods, monuments were often enhanced with panels of stucco, ivory, glass, wood and costly stone. Carved or inlaid with geometric, floral or epigraphic motifs, such panels provided visual accents on doors, walls and windows and could be incorporated into minbars, mihrabs and other furnishings.

This example, carved in white marble, may be compared with pieces executed in other materials in which a phrase of monumental calligraphy is set against a background of spiralling vines. The wood carvings of the Mausoleum of Sayyida Nafisa in Cairo are particularly close in style (eg. Museum of Islamic Art, Cairo, no.1655; G. Wiet, *Album du Musée Arabe du Caire*, Cairo, 1930, p.29). No other comparable piece in marble is recorded.

◄ 73 Inlaid Panel

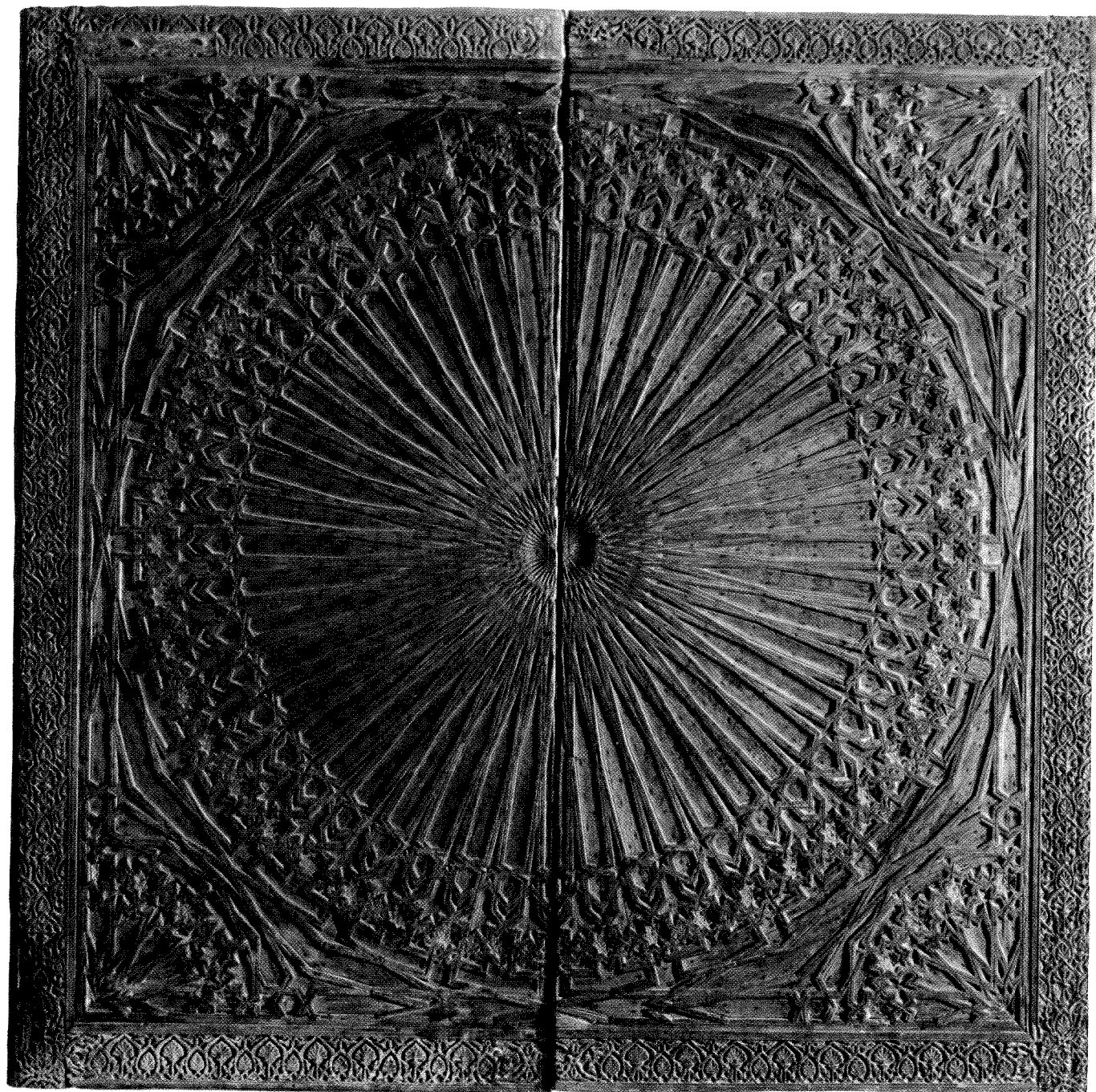
Egypt, 14th century
Mosaic of glazed faience, marble and stone
Size: 49 cm square

This panel consists of an inscription in square Kufic framed with a broadly conceived meander pattern. The calligraphy is executed in glazed faience of red, light blue and pale green, while the background is composed of white marble sections. The border is made up of different colored stones. There is a similar panel in the University Museum of the University of Pennsylvania.

74 Fountain Head

Egypt, 14th century
Green onyx
Size: 55 cm × 48 cm

The fountain head has eight spouts in the form of rosettes, each on a fluted column around a domed octagon with another spout in the center. The roof of the dome is pierced and carved with four lotus flowers, each framed by a split palmette. The octagon stands on a square base with a spout in each corner and a recessed lip to the front.

The base would have originally stood on four legs in the center of a large fountain. It probably originally came from a Mamluk palace in Cairo, and is similar to another example in the Museum of Islamic Art (no.4568; see G. Wiet, *Album du Musée Arabe du Caire*, Cairo, 1930, pl.14).

◄ 75 Pair of Doors

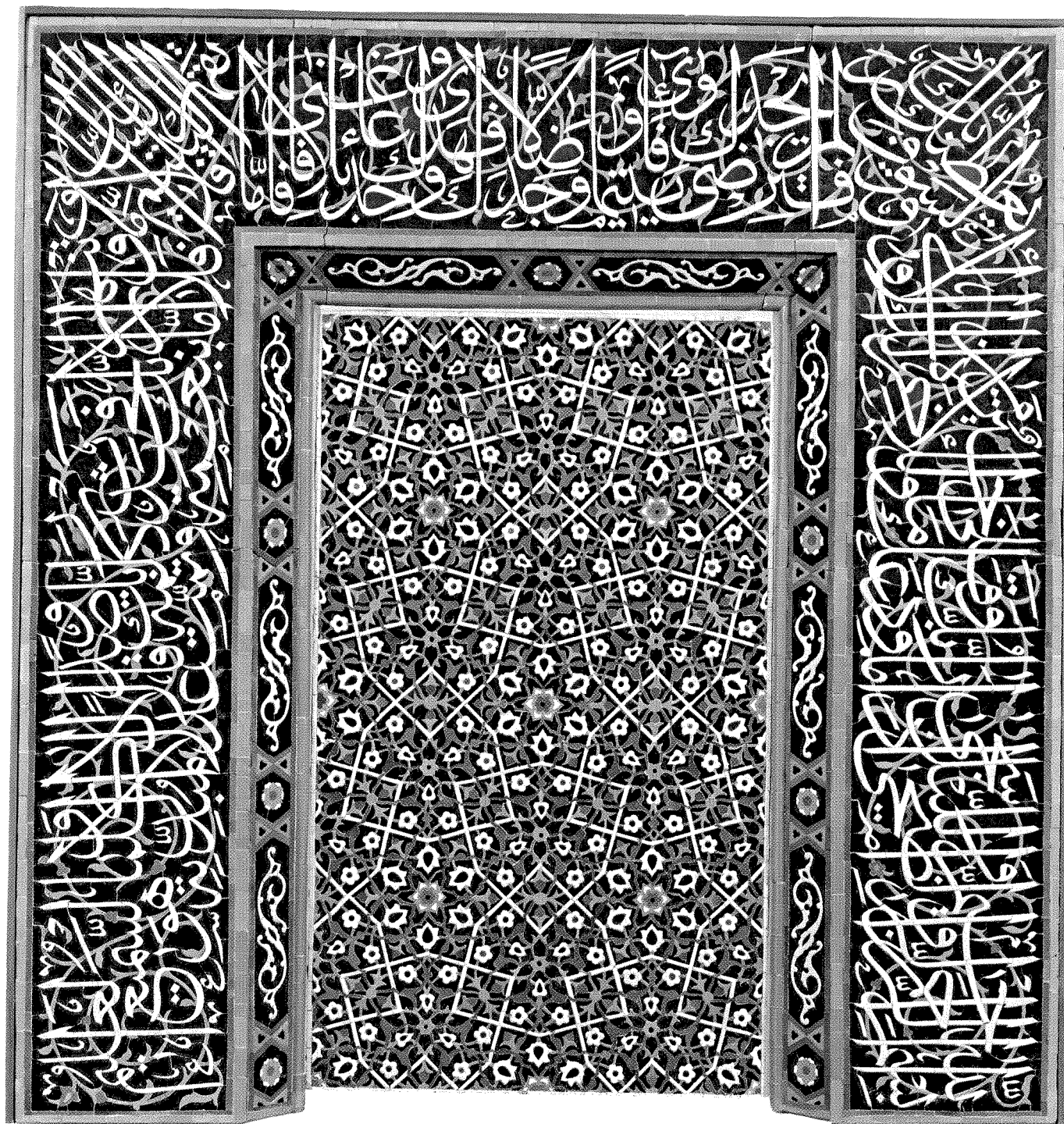
Morocco, 14th–15th century
Carved Atlas pine wood
Size: 2 m square

These doors are made of pieces of Atlas pine, assembled with various joinery techniques and then carved. They were originally the upper portion of a large double door more than four and a half meters high, which must have graced an important palace or religious building. (see M. Jenkins, *Islamic Art in the Kuwait Museum: The al-Sabah Collection*, London, 1983, p.109, no. LNS 52 Wab.)

The monumentality achieved in the design of these doors is peculiar to the Maghrib and remains unmatched elsewhere in the Islamic world. From the center, a 48-point star expands across the entire surface of the Doors, generating a complex radial geometry. Smaller stars of the same format appear in the corners. The border consists of large and small palmettes, in curving frames, the forms of which contrast pleasantly with the straight lines of the central design.

76 Bar from a Window Grill
Inscribed with the titles of Sultan Qaitbay

Syria or Egypt, 15th century
Length: 132.5 cm

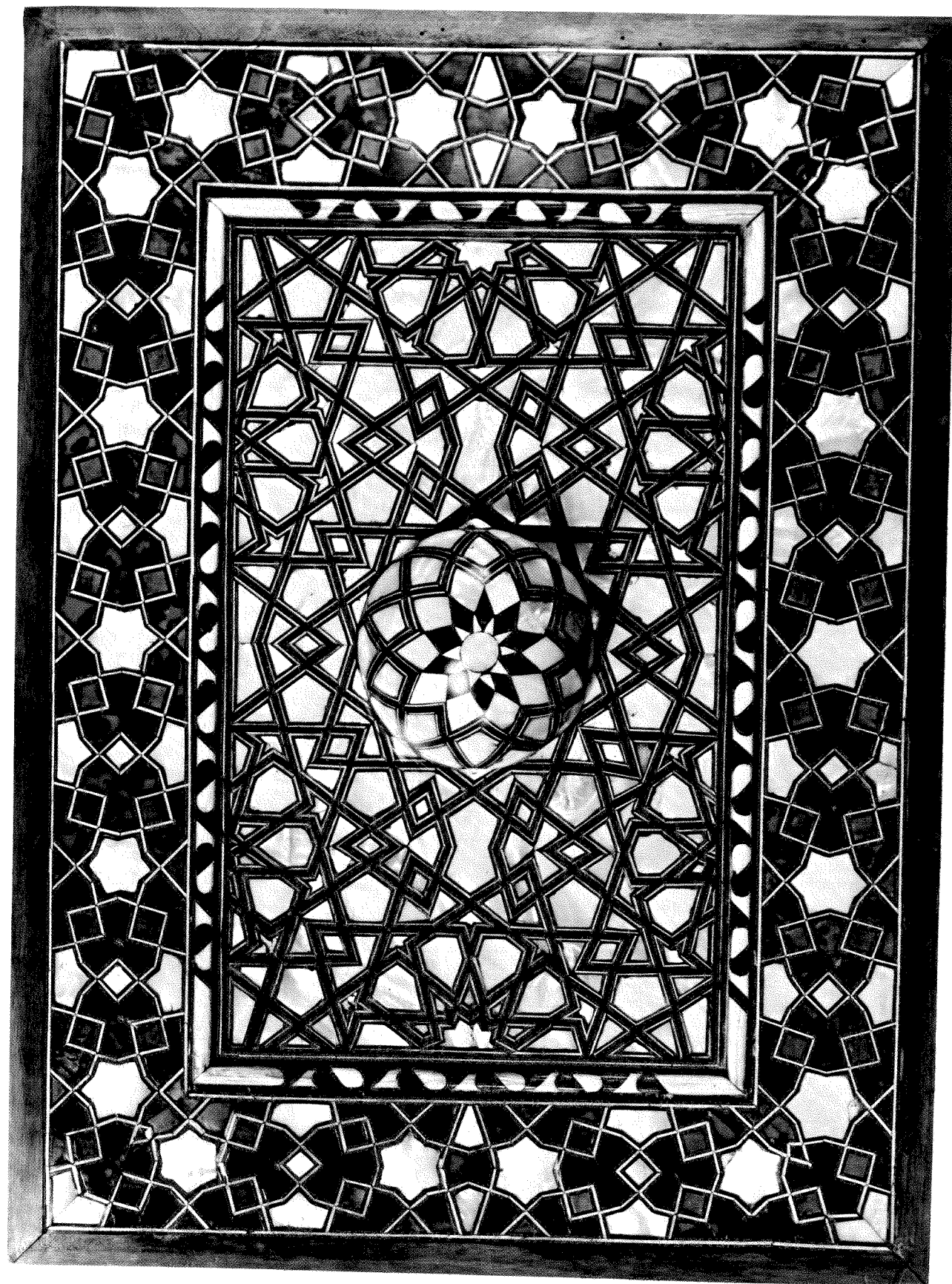
Inscription on the two central joints: "Glory to our Master, the Sultan, the King, Qaitbay, may his victory be glorious." Qaitbay, the ruler of Egypt and Syria, reigned between 1468 and 1498.

◄ 77 Mihrab

Iran, second half of 15th century
Glazed ceramic mosaic
Height: 171 cm
Width: 161 cm

Inscriptions: Qur'an Sura XCIII (complete) and Sura VI, v.116

The central panel has a geometric design set on a black ground of white interlocking irregular hexagons interwoven with two systems of floral arabesques, one in brown and the other in turquoise, with flowers in white and green. The dark blue border has a magnificent white Thuluth inscription set against a turquoise scrolling vine with small brown flowers. Some letters have olive-green infill. The recessed band has black cartouches with a white arabesque motif between turquoise and brown edges.

Glazed ceramic pieces were first used to adorn architecture in the 12th century in Iran. The technique was developed to such a point that in the 14th and 15th centuries craftsmen were capable of covering large areas, and Mihrabs such as this were characteristic of many of the major mosques built at this time. In the 16th century, the less exacting method of painting designs on large tiles gradually supplanted the mosaic technique. It required the most extraordinary precision in cutting the glazed ceramic to render an inscription of the type on this Mihrab, where every piece is a different shape, and where the whole effect depends on the accuracy of line. Even in the central panel, which is relatively more straightforward, there are three superimposed designs.

The Mihrab was originally in the winter-hall of one of the mosques in Isfahan that was demolished in the course of the urban re-development of the city in about 1930. The main Mihrab from the same mosque is now in the new mosque at King Abdul Aziz Airport, Jeddah. Besides these, three other Mihrabs were rescued. One is now in the Metropolitan Museum, New York (Harris Brisbane Dick Fund, 1939 – 39.20; exhibited at the Persian Exhibition, London, 1931) and another is in the Cleveland Museum of Art, Cleveland, Ohio (Gift of Mrs. Katharine Holden Thayer, 62.23).

◄ 78 Inlaid Panel

Egypt, second half 16th century
Wood inlaid with mother-of-pearl, ivory, ebony, bone, tortoiseshell and gold leaf
Height: 66.5 cm
Width: 49 cm

This exquisite inlaid panel was executed by craftsmen working in Cairo at the behest of the Ottoman sultan. A label on the reverse states that it was one of the two removed from the octagonal kiosk of the Mosque of al-Azhar when it was dismantled in 1872. One was taken to Istanbul and sold to Monsieur Schefer, a renowned collector. The other was acquired by Baron des Michels, French minister in Egypt. After Monsieur Schefer's death in 1898, Baron des Michels bought the second panel, thus reuniting the pair.

The craftsmanship of this panel is remarkable. The central zone consists of a geometric trellis of wood outlined in ivory, the interstices of which are filled with mother-of-pearl. At the center, a domed boss stands in high relief. The border has a geometric pattern in tortoiseshell and mother-of-pearl, framed by raised borders in ebony and bone. The tortoiseshell is set over thin sheets of gold leaf to enhance the color.

Provenance: Baron des Michels Collection.

Metalwork

◄ 79 Ewer

Syria or Iraq, late 7th/early 8th century
Brass or bronze
Height: 37.5 cm

Of pear-shaped form, this ewer stands on a high, sloping foot. There are two leaf-shaped flanges on opposite sides of the flattened rim, and a simple raised collar at the base of the neck. The handle has a stylized gazelle's head at the base and six pearl-shaped knobs half way up its length. It ends in a bold palmette finial, topped with another knob. The exterior of the ewer is covered with a golden brown patina.

A comparable ewer in the Hermitage in Leningrad, made by Abu Yazid in Basra, is dated 69 (689–90).

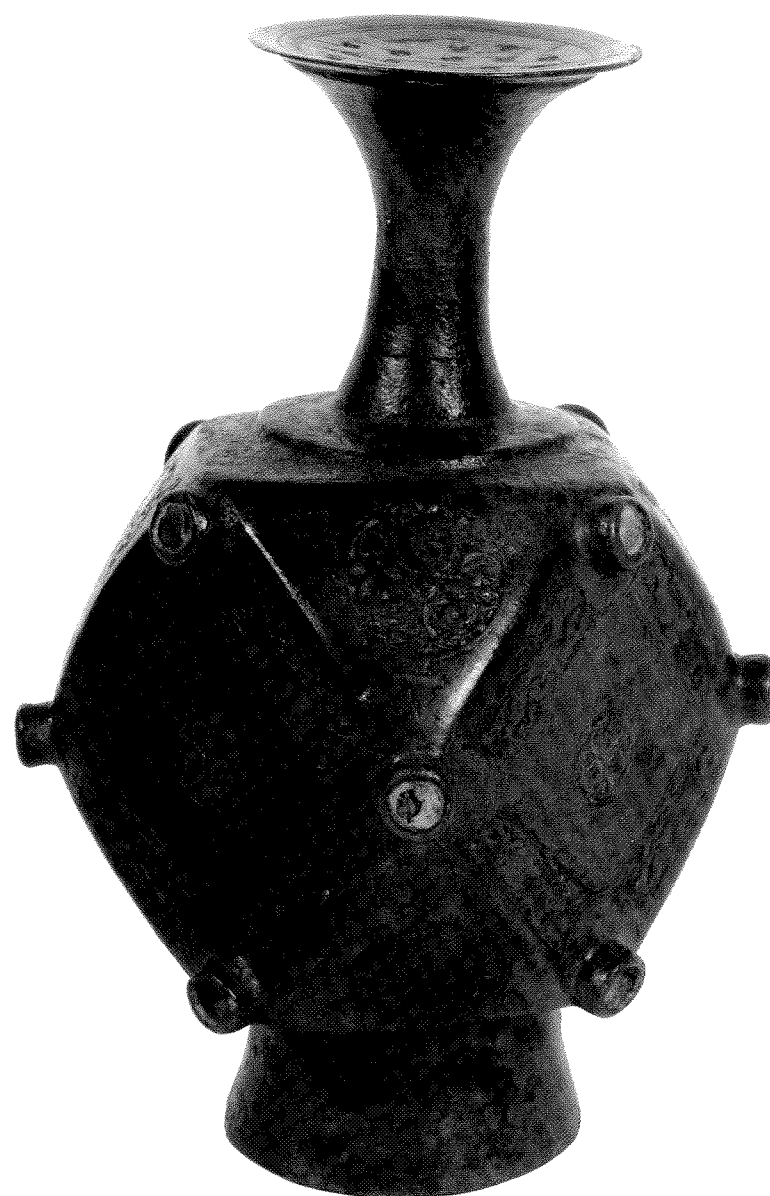
Provenance: Prince Sadruddin Aga Khan Collection.

Published: Anthony Welch, *Collection of Islamic Art of Prince Sadruddin Aga Khan,* Geneva, 1972, Metal III, no.3.

80 Ewer

Iran, 8th century
Brass or bronze
Height: 32 cm

The upper part of the pear-shaped body is decorated with horizontal ribbing and the lower part has rectangular panels, each enclosing an 'X' motif. The neck rises to a spout engraved with a vine pattern. The handle has a pomegranate-shaped knob, beading in the middle and a stylized gazelle head terminal.

Another ewer of very similar form, but with palmette decoration on the body, is in the al-Sabah Collection in the Kuwait National Museum (LNS84M; see M. Jenkins, *Islamic Art in The Kuwait National Museum:* London 1983, no.37). These ewers illustrate the transition between the Sasanian and early Islamic forms in Iran.

◀ 81 Polyhedral Sprinkler Flask

Iran or Afghanistan, 12th century
Brass or bronze
Height: 18 cm

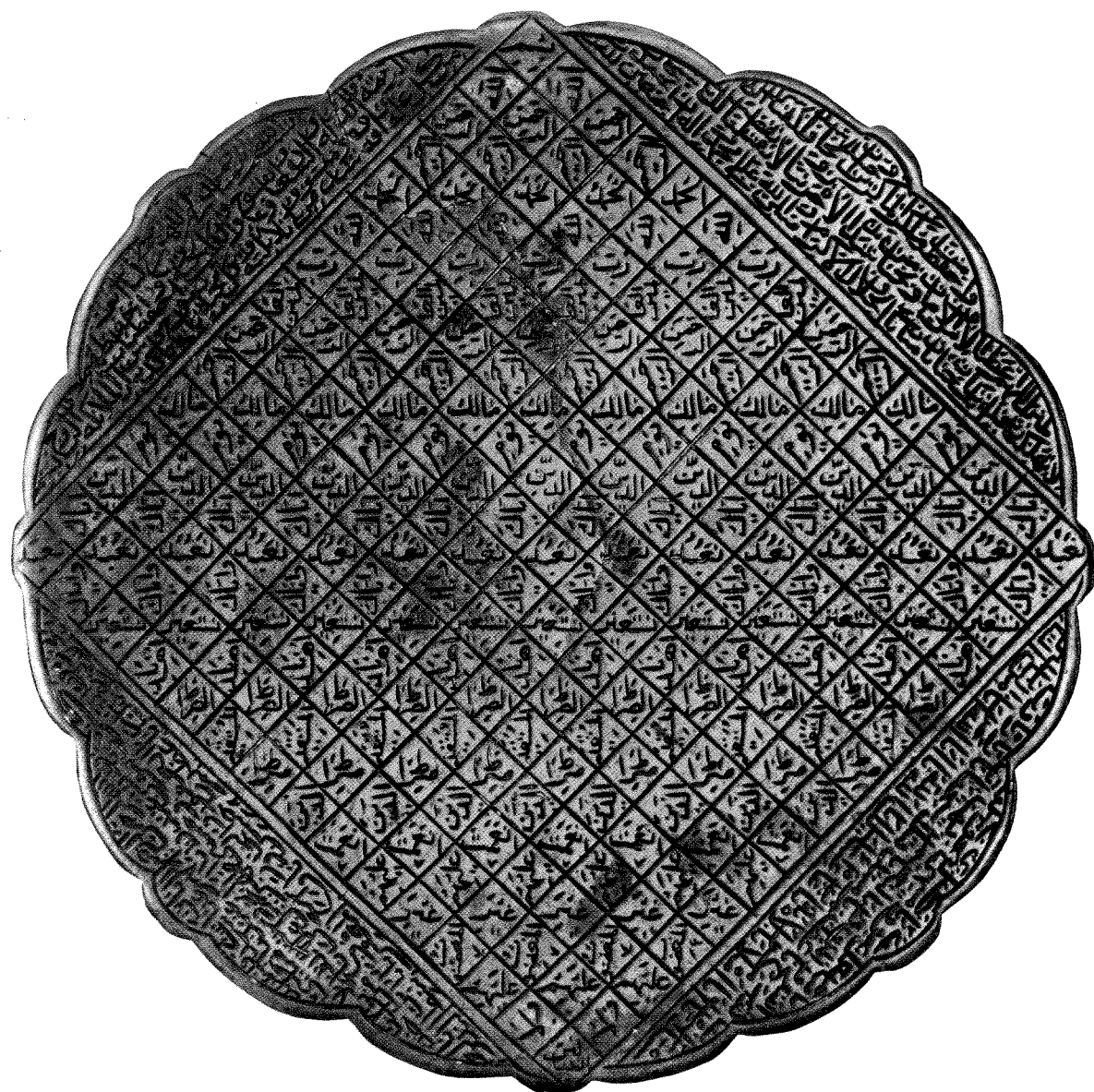
The roughly spheroid body of this flask, bulging over a high flaring foot, is chamfered into four square faces and eight triangular faces. Each square face is engraved with a floral medallion at the center and an animal set in a rectangular cartouche along each side. The triangular panels are enhanced with a circle of vines. At each corner of the polyhedron there is a protruding socket set with a turquoise. The tall, slender neck retains the pierced lid of a sprinkler.

A similar flask is in the Victoria and Albert Museum, London (no.777–1889; see A. S. Melikian-Chirvani, *Islamic Metalwork from the Iranian World*, London, 1982, no.5). An example of identical shape made of blue-glazed pottery is in the Metropolitan Museum of Art, New York (no.1975.164).

◀ 82 Cat

Iran or Afghanistan, late 12th century
Brass or bronze
Height: 9 cm
Length: 17 cm

The cast bronze cat is decorated with two panels of calligraphy against scrolling vines on its back, and two roundels enclosing figures of peacocks on its haunches. The shoulders are defined with engraved arcades, and its chest and face are decorated with engraved palmettes.

Various animal figures, such as lions and birds, were made in bronze or brass. Some were intended as incense burners and were made with pierced designs, and others were intended as supports or finials. This figure of a cat seems to be an example of an animal sculpture intended as an ornament.

◄ 83 Mirror

Iran, 12th century
Brass or bronze
Diameter: 12.7 cm

The face is engraved with a square of 225 compartments. Each square is engraved with a word from the Surat al-Fatiha, starting at the apex, so that the whole Sura can be read in sequences following the sides of the square, while each word occupies an entire line across the diagonal. A prayer is repeated on each lobed section. The back is cast with two addorsed sphinxes within a Kufic border, and the outer border is engraved with prayers.

The engraving is probably somewhat later than the mirror itself, and is executed with great precision. (See *Art Islamique dans les Collections Privées Libanaises*, Beirut, 1974, no.143 for another engraved mirror).

84 Lamp

Iran, 12th century
Brass or bronze
Height: 18.5 cm

Inscriptions: *On rim*
"Good fortune and complete blessings"
Around body
Similar to above
On neck
Two rectangles with words "the work of"

This lamp is shaped like a vase with a broadly flaring rim. The body is pierced with an openwork inscription of bold Kufic, framed by cable pattern borders. Above the inscription and on opposite sides of the lamp are two pierced medallions, each containing a bird; between the medallions on each side is a pierced vertical panel of Kufic. Around the neck is a collar with a scrolling vine in relief, and around the inside of the rim is a bold, floriated Kufic inscription in voided relief against a stippled background. Calligraphy similar to that in the rim inscription can be seen on a lamp on the Louvre in Paris (A.O. no.7890, illustrated in *L'Islam dans les collections nationales*, Paris, 1977, pl.56).

Provenance: Prince Sadruddin Aga Khan Collection

Published: Anthony Welch, *Collection of Islamic Art of Prince Sadruddin Aga Khan*, Geneva, 1972, Metal, III, no.5.
Oleg Grabar, *Persian Art before and after the Mongol Conquest*, Ann Arbor, 1959, no.29.

◄ 85 Tray

Afghanistan, 12th century
Beaten brass or bronze engraved and inlaid with silver
Length: 32.5 cm
Width: 20.5 cm

Inscriptions: *Around the rim*
"Glory, prosperity, wealth, happiness, well-being,
Grace and entire?... and (God's) support and
health, sympathy
And... and sufficiency, honor and wealth.
Ease, mercy, long life and perpetual praise to its owners"
Inside the rim
"Good fortune, blessing, wealth and perpetual life to its owner"

The tray is of beaten copper alloy that is engraved and inlaid in silver. The lobed well includes a geometric roundel framed by two panels of Kufic calligraphy. Around the sides are four hunting hounds, arabesques and rosettes. The recessed spandrals are of floral arabesques, and the outer borders have Kufic punctuated by rosettes and palmettes.

Other examples are in the Walters Art Gallery, Baltimore, (no.54.530, acquired from the Kelekian Collection, Paris, 1930) and in the Louvre, Paris, (MAO 498 and 499, acquired in 1976).

◄ 86 Ewer
Made by Tahir Ali

Iran or Afghanistan, 12th century
Brass inlaid with copper
Height: 35.5 cm

Inscriptions: *Neck*
"Blessings and well-being...good fortune"
Around the shoulder
"With good fortune and blessing and well-being and happiness and glory and prosperity"
Front of the body
"The work of Tahir Ali"

The ewer is unusually solidly made and the thick brass gives it unexpected weight. The Kufic inscriptions are inlaid in copper against stippled backgrounds on the neck, around the shoulder and along the top front edge of the body. Below this is a niche-shaped cartouche, enclosing two parrots among swirling plant forms, which is also inlaid with copper. The handle, upper neck and spout are inlaid and engraved, and the top of the spout is pierced like a filter.

◄ 87 Incense Globe

Iran or Afghanistan, circa 1200
Brass inlaid with silver
Diameter: 13.2 cm
Inscriptions: *On the circular band*

"Glory and prosperity and wealth and entirety and tranquility and inner-calm and contentment and gratefulness and happiness and well-being and health"

On the bands which make up the pentagram

"Glory and prosperity and wealth and inner-calm and glory and prosperity and entirety and gratefulness and tranquility and mercy and inner-calm and well-being and endurance and success and mercy and inner-calm and contentment and gratefulness and endurance and health and grace and tranquility and entirety"

The surface of the globe displays the twelve astrological signs, each sign enclosed in a pentagon. On one hemisphere the signs of Saturn in Aquarius, Mercury in Pisces, Venus in Libra, Mars in Scorpio, Planetary Eclipse in Sagittarius and Saturn in Capricorn are set within interlaced bands of calligraphy forming the pentagons. On the other hemisphere, the signs of Mars in Aries, Venus in Taurus, Mercury in Gemini, the Moon in Cancer, the Sun in Leo and Mercury in Virgo are set within interlacing bands of running animals. Each triangle encloses a small face. The decoration is entirely inlaid in silver, with engraved details on the astrological figures and animals.

This appears to be the only known spherical incense burner from the eastern Islamic world, although examples from Syria and Turkey are published. It fits the description of such objects given by the Arab traveler al-Biruni who stated that such globes were rolled between the guests after dinner. The gimballed support system inside prevented the coals and incense from spilling and a pleasant aroma could be disseminated unobtrusively.